Space Sciences Laboratory
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Berkeley, California 94720

AD656754

Semi-Annual Report on

SOLAR RADIATION AND ATMOSPHERIC ABSORPTION IN THE MM WAVE REGION

Supported by

ONR Contract
Nonr 222(54)

For the period
May 1 through October 31, 1966

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N67-86589 (ACCESSION NUMBER) (THRU)
4 (PAGES) (CODE)
AD-656754 (NASA CR OR TMX OR AD NUMBER) (CATEGORY)
CR 88994
FACILITY FORM 602

Acquisitioned Document
SQT

Space Sciences Laboratory Series No. 7, Issue No. 51
September 30, 1966

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(Part of this work was supported also by the National Aeronautics and Space Administration under Grant NsG 243.)

The work supported by this contract has four principal objectives: (1) to study the absorptive and emissive properties of the earth's atmosphere in the millimeter wave region; (2) to use such studies for remote sensing of the temperature and pressure structure of the atmosphere; (3) to study the effective microwave emission temperatures of the planets and the relation between the emission and various models of the planets' surfaces and atmospheres; and (4) to develop radiometric techniques for the millimeter wave region.

1. Ozone

During this period the laboratory phase of the study was completed and the detection of both emission and absorption by atmospheric ozone was accomplished.

In the laboratory, the lines at both 36 Gc and 37 Gc were studied. The absorption cell consisted of a five-foot length of Ka band stainless steel wave guide. A 9% mixture of O_3 and O_2 was introduced into the guide at a total pressure of 40 mm Hg. The absorption was studied by two techniques. The first technique employed the frequency switching radiometer (described previously), which was used later for the atmospheric study; the absorption of the radiation from an argon discharge tube at one end of the guide was observed. For the second study a sweeping oscillator was connected to one end of the waveguide and a crystal detector connected to the other. The two sets of measurements agreed. The observed line strengths and widths were in reasonable agreement with values derived from the 10 μ vibrational-rotational band.

Then the switching radiometer was installed on the antenna and observations of the 30, 36, and 37 Gc atmospheric lines were made, both in absorption against the sun and in emission using low elevation antenna angles. All three lines were detected; the shapes and widths were in reasonable agreement with the calculated values.

A final report discussing these findings in detail is in preparation. Future studies of these lines will be made with the multichannel radiometer discussed in the previous report.

2. Emission from Atmospheric H_2O

Both the liquid nitrogen and ambient temperature blackbody terminations were completed during this period. Since this study attempts to relate absolute sky brightness temperature measurements to emission by atmospheric water vapor, it was decided first to focus attention on the cosmic background radiation at 1.5 cm. Such measurements would, of course, be very important in themselves. Accordingly, the radiometer was installed in the infrared trailer and transported to the Barcroft Laboratory in the White Mountains. At this altitude (13,000 feet), only a fraction of the amount of water vapor lies above the observing platform that lies above a sea level site, such as Berkeley, and the background signals can be separated more easily from the atmospheric contribution. To date, only preliminary measurements have been made; however, complete results should be available shortly. Depending on the outcome of this experiment, observations of the cosmic background at 8 mm also may be carried out.

3. Planetary Studies

During January observations of Jupiter, Venus, and Taurus A were made at 1.35 cm on the 10-foot antenna. The new mount performed satisfactorily. In March the k-band receiver, equipped with the 8-channel filter system described in the previous report, was installed on the 85-foot antenna of the Hat Creek Observatory. During late March and early April, the multichannel receiver was centered on the 1.35 cm absorption wavelength of water vapor and Venus was observed. Over the effective overall receiver

bandwidth of 300 mc/s, the emission spectrum of Venus was found to be flat within a few percent. This result will be translated shortly into an upper limit for water vapor in the planet's atmosphere. Observations are planned for the next conjunction with somewhat greater overall bandwidth.

4. Receiver Developments

As noted above, the 8-channel receiver has been completed and has been found to work satisfactorily. For the Venus observations the receiver was coupled to the first eight channels of the 100-channel data storage system that is normally in use with the 85-foot antenna. A separate 8-channel data system is currently being developed.

Improvements in our microwave crystal mixers are under way along two lines. Specially designed crystal holders, which will have minimum capacitance and, hence, allow for increased IF bandwidth, are under construction. In addition, the mixer is being designed to fit into a dewar, so that it may be cooled to the temperature of liquid nitrogen, 78° K. It is hoped in this way to lower the receiver noise temperature to a few hundred degrees (kelvin) at 8 mm.

Publications:

Welch, W. J., D. D. Thornton, and R. Lohman. Observations of Jupiter, Saturn, and Mercury at 1.53 cm. Astrophys. J. (In press).

Griffith, P. H., D. D. Thornton, and W. J. Welch. The Microwave Spectrum of Venus in the Frequency Range 18-26 Gc. Icarus. (In press).

Welch, W. J. Millimeter Wave Radio Astronomy. Presented at WESCON-66, Los Angeles, August 23, 1966.

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